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**BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES**

Application Number: 10/771,267
Filing Date: February 02, 2004
Appellant(s): BRASK ET AL.

Michael Plimier
For Appellant

EXAMINER'S ANSWER

MAILED

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This is in response to the appeal brief filed May 11, 2006 appealing from the Office action mailed December 20, 2005.

(1) Real Party in Interest

A statement identifying by name the real party in interest is contained in the brief.

(2) Related Appeals and Interferences

The examiner is not aware of any related appeals, interferences, or judicial proceedings which will directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

(3) Status of Claims

The statement of the status of claims contained in the brief is correct.

(4) Status of Amendments After Final

The appellant's statement of the status of amendments after final rejection contained in the brief is correct. The amendment filed February 15, 2006 was entered.

(5) Summary of Claimed Subject Matter

The summary of claimed subject matter contained in the brief is correct.

(6) Grounds of Rejection to be Reviewed on Appeal

The appellant's statement of the grounds of rejection to be reviewed on appeal is correct.

(7) Claims Appendix

The copy of the appealed claims contained in the Appendix to the brief is correct.

(8) Evidence Relied Upon

20030045080	VISOKEY ET AL.	03-2003
6,845,778	BOYD ET AL.	01-2005
20040043569	AHN ET AL.	03-2004

(9) Grounds of Rejection

The following ground(s) of rejection are applicable to the appealed claims:

Claims 27-31 are rejected under 35 U.S.C. 103(a) as being unpatentable over Visokay et al. (US 20030045080) in view of Boyd et al. (US 6,845,778).

Regarding claim 27, Visokay discloses forming a high-k gate layer on a substrate, the high-k gate dielectric layer having impurities (incorporated carbon) and oxygen, exposing the high-k gate dielectric layer to a solution including hydrogen peroxide at a sufficient time and temperature to remove impurities from the high-k gate dielectric layer and to increase the oxygen content of the high-k gate dielectric layer, and forming a gate electrode on the high-k gate dielectric layer (para. 0023-0033). Visokay does not disclose applying sonic energy while the high-k gate dielectric layer is exposed to the solution that includes hydrogen peroxide. Visokay teaches that the treatment of the high-k gate dielectric layer "can be performed in conventional immersion tanks" (para. 0029). Boyd discloses that it is well-known in the art to use megasonic cleaning to rid semiconductor wafers of impurities because the sonic energy applied to the wafers causes the rapid forming and collapsing of microscopic bubbles in a liquid medium under the action of sonic agitation. Upon collapse, the bubbles release energy, which assists in particle removal through breaking the various adhesion forces which adhere the particle to the substrate

(col. 1, ln. 10-31). Boyd teaches a megasonic cleaning apparatus that uses a hydrogen peroxide solution to clean semiconductor substrates (col. 6, ln. 20-29). At the time of the invention, it would have been obvious to one of ordinary skill in the art to use the megasonic cleaning system taught by Boyd to clean the high-k gate dielectric layer of Visokay because Visokay does not disclose using any particular cleaning apparatus and because Boyd teaches that by applying sonic energy to the cleaning solution, better impurity removal can be obtained.

Regarding claims 28 and 29, Boyd discloses that the sonic energy can be applied at a frequency of 400-1500kHz, while dissipating at 3-5 W/cm^2 (col. 6, ln. 40-48).

Regarding claims 30 and 31, Visokay discloses that, in one example, the hydrogen peroxide solution is an aqueous solution containing 5% hydrogen peroxide by volume and the high-k gate dielectric layer is exposed to the aqueous solution at a temperature of 65°C for 7 minutes (para. 0024). Visokay does not disclose a range of cleaning parameters. At the time of the invention, it would have been obvious to one of ordinary skill in the art to use routine experimentation to determine optimal H_2O_2 concentrations, time and temperatures at which to conduct the cleaning process of Visokay, depending upon the composition and thickness of the high-k gate dielectric layer because such variables of art recognized importance are subject to routine experimentation and discovery of an optimum value for such variables is obvious. See *In re Aller*, 105 USPQ 233 (CCPA 1955). Note: Applicant's specification, page 6, lines 13-16 states, "The appropriate time and temperature at which high-k gate dielectric layer is exposed [to the cleaning solution] may depend upon the desired thickness and other properties for high-k gate dielectric layer **110**."

Claims 32-34 are rejected under 35 U.S.C. 103(a) as being unpatentable over Visokay et al. (US 20030045080) in view of Boyd et al. (US 6,845,778) as applied to claim 27 above, and further in view of Ahn et al. (US 20040043569).

Regarding claims 32 and 33, Visokay discloses that there are impurities in the high-k gate dielectric layer but does not specifically disclose that these impurities include chlorine. Visokay teaches that a variety of methods such as CVD and PVD may be used to deposit the high-k gate dielectric layer (para. 0020). Like Visokay, Ahn discloses a process of forming a high-k gate dielectric layer made of hafnium silicon oxynitride. Ahn teaches that the high-k gate dielectric layer should be deposited using an ALD-CVD process because the ALD-CVD process offers the advantage of being able to precisely control the thickness of the gate dielectric layer (para. 0009). Additionally, Ahn teaches that sputtering the high-k gate dielectric film is not desirable because the sputtering process causes an interfacial SiO_2 film to be formed on the surface of the substrate which limits the equivalent oxide thickness scaling that can be attained for the gate dielectric (para. 0035). At the time of the invention, it would have been obvious to one of ordinary skill in the art to use the ALD-CVD process taught by Ahn to deposit the high-k gate dielectric layer of Visokay because Ahn teaches that ALD-CVD provides significant advantages to the gate dielectric layer over sputtering and other deposition methods. Ahn teaches that the process of using ALD-CVD to deposit the high-k gate dielectric layer involves using a metal chloride precursor, such as $HfCl_4$, and a silicon chloride precursor, such as $SiCl_4$ (para. 0064, 0069). Using $HfCl_4$ and/or $SiCl_4$ precursors for the deposition of the gate dielectric layer ensures that impurities of chlorine will inherently be formed throughout the high-k gate dielectric layer.

Regarding claim 34, Visokay discloses depositing a high-k gate dielectric layer on a substrate and subjecting the high-k gate dielectric layer to a liquid cleaning solution of hydrogen peroxide in order to remove impurities from the gate dielectric layer. Visokay does not specifically disclose the percentage of impurities removed from the layer. At the time of the invention, it would have been obvious to one of ordinary skill in the art to use routine experimentation to determine optimal time and temperatures at which to conduct the cleaning process of Visokay in order to achieve removal of 80% or more of the impurities, depending upon the composition and thickness of the high-k gate dielectric layer and the concentration of the cleaning solution because such variables of art recognized importance are subject to routine experimentation and discovery of an optimum value for such variables is obvious. See *In re Aller*, 105 USPQ 233 (CCPA 1955). Note: Applicant's specification, page 6, lines 13-16 states, "The appropriate time and temperature at which high-k gate dielectric layer is exposed [to the cleaning solution] may depend upon the desired thickness and other properties for high-k gate dielectric layer **110**."

(10) Response to Argument

I. <u>Rejection of claim 27 under 35 U.S.C. §103(a) as being unpatentable over Visokay in view of Boyd.</u>

Regarding the rejection of claim 27 as being unpatentable over Visokay in view of Boyd, Applicant argues that there is allegedly no motivation to combine the megasonic cleaning method of Boyd with the cleaning method of Visokay. Contrary to Applicant's statement, the treatment step of Visokay is not solely concerned with oxidizing the high-k dielectric layer to remove oxygen vacancies. Visokay states that this treatment step *also* cleans impurities of

"incorporated carbon" from the high-k dielectric layer (para. 0024 and 0031). Visokay recites that the treatment of the high-k gate dielectric layer "can be performed in conventional immersion tanks" (para. 0029). Boyd teaches a method of treating a semiconductor substrate in order to clean impurities therefrom. Specifically, lines 6-9 of column 1 of Boyd state, "The present invention relates generally to surface cleaning and, more particularly, to a method and apparatus for megasonic cleaning *following fabrication processes*" (emphasis added). Additionally, lines 41-44 in column 8 of Boyd state, "As mentioned previously, liquid **166** includes cleaning chemistries designated for single wafer cleaning processes performed *after various semiconductor process steps*, such as CMP, etch, *deposition*, implant, etc." (emphasis added). Therefore, Boyd states that his cleaning method may be used after a step in which a material (such as the high-k dielectric layer of Visokay) is deposited onto a semiconductor substrate in order to remove impurities therefrom. Furthermore, Visokay and Boyd both teach using the same cleaning liquid (hydrogen peroxide). Regarding the motivation to use the megasonic apparatus of Boyd in the treatment process of Visokay, Boyd specifically states that the megasonic cleaning is advantageous because, "the main particle removal mechanisms with megasonic cleaning is due to cavitation and acoustic streaming. Cavitation is the rapid forming and collapsing of microscopic bubbles in a liquid medium under the action of sonic agitation. Upon collapse, the bubble release energy which assists in particle removal through breaking the various adhesion forces which adhere the particle to the substrate." (col. 1, ln. 19-26). Therefore, because the megasonic apparatus provides greater turbulence in the process liquid, the high-k dielectric layer of Visokay can thereby be oxidized and cleaned with greater power and efficiency.

Regarding the rejections of claims 28-31, Applicant has not separately argued these rejections. Therefore, claims 28-31 stand or fall with claim 27.

II. Rejection of claims 32 and 34 under 35 U.S.C. §103(a) as being unpatentable over Visokay in view of Boyd and Ahn.

Regarding the rejections of claims 32 and 34, Applicant has not separately argued these rejections. Therefore, claims 32 and 34 stand or fall with claim 27.

III. Rejection of claim 33 under 35 U.S.C. §103(a) as being unpatentable over Visokay in view of Boyd and Ahn.

Regarding the rejections of claim 33, Applicant has not separately argued this rejection. Therefore, claim 33 stands or falls with claim 27.

(11) Related Proceeding(s) Appendix

No decision rendered by a court or the Board is identified by the examiner in the Related Appeals and Interferences section of this examiner's answer.

For the above reasons, it is believed that the rejections should be sustained.

Respectfully submitted,

CLN
July 19, 2006

Conferees:

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Supervisory Patent Examiner